1999

Digital Image access in an educational environment

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Thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Information Technology

Department of Information Technology
Rochester Institute of Technology

November 1, 1999

Rochester Institute of Technology
Department of Information Technology

Master of Science in Information Technology
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Rochester Institute of Technology
September 1999

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Abstract

The thesis *Digital Image Access in an Educational Environment* explores multiple approaches to image system design and deployment in the academic setting. This discourse chronicles the issues, options, design considerations, technical challenges, and organizational and social factors inherent in Internet and network access to, and use of, collections of high-resolution digital images in the university environment. Discussion focuses upon advances undertaken or participated in at Rochester Institute of Technology (RIT) by Wallace Library to provide digital image access to the RIT community. Efforts include the development of a local image system, the beta testing of a national image delivery system and the purchase of commercial image systems.

While this examination details one institution's foray into encouraging a change through digital image systems experimentation and implementation, as an enhancement to campus-based and distance education curriculum, it is intended to inform other educational institutions in their approach to the same issue.

Introduction

Exploring the delivery of digital images in a campus wide setting, this treatise provides brief, recent background into RIT image production, image use and select assets in place to bring a shift from a reliance on physical images, support of RIT curriculum and study, to the availability of network access to digital images.

Four digital image system projects undertaken by or participated in by Wallace Library are explored with the chief areas of examination being human-computer interaction (HCI), technical standards, technical requirements, educational issues, and strategic impact.

Each case study represents a team-based project, requiring the work of different players to complete. My role within each has varied. In the first two project ventures described, the construction of a local RIT image system and the participation of Wallace

Library in a national beta image system testbed where significant design and development work was required, my function was that of primary decision point in final design approval and implementation. In the final endeavors detailed, the procurement of vendor produced image systems, my position has been one of financial backing, and amalgamator into the overall library networked database offerings.

As with all system implementations, the image systems detailed in each case are evolving. The discussion that follows represents a snapshot of discoveries and issues encountered through July 1999.

Background of the Local Environment

An overview of the local environment is paramount to understanding how and why each image database project was undertaken. The solutions offered by the image systems projects have their respective advantages and disadvantages as related to the problem, the RIT setting, and the desired outcome. The local environment plays a key role in all stages, including the success and usefulness, of selected approaches. What follows is a brief impression of local factors as a common backdrop to the digital image system undertakings.

RIT Campus Computing

Information Systems and Computing (ISC) manages 17 computing facilities and labs, and smart classrooms, across the RIT campus including eight specifically for the students in five colleges. Most labs are open seven days a week, averaging 92 hours weekly, and contain from 30 to 50 microcomputers, workstations, printers, and peripherals. Service is provided to several thousand students daily. Most of the ISC-managed facilities are available on a walk-in basis although some can be reserved for classes or are restricted to specific programs. All facilities have access to the VMScluster, the Grace/DCE system and have Internet access.[1]

The upgrade of the RIT campus infrastructure is close to fully deployed in the academic buildings and 100% complete in the dormitories. This network upgrade brings multiple Ethernet connections to each faculty office and to all classrooms on campus. The general specification for the network started at 10Mb (minimum) to each connection, with 100Mb connection becoming the standard in year two of the 3-year project. In addition to the necessary network bandwidth, appropriate level on-site projection equipment and personnel support are also required. The commitments to the classroom upgrades including a variety of projection options are in process. By the end of summer 1999, approximately 50% of the classrooms will have projection capability.

Some questions still exist regarding deployment of smart classroom installations, but the commitments to upgrade classrooms has been made, thus bringing a key factor in

line with the classroom use of digital image collections in the very near term future. In addition to classrooms, the commitment to this level of equipment and subsequent upgrades is necessary at the faculty level, campus computing service points and at traditional campus access points such as the Library and ETC.

Wallace Library

Wallace Library provides access to information that supports the teaching and learning mission of RIT. To support the use of information resources, the library offers multiple options for consultation and instructional services. In-person instructional offerings reached approximately 7,100 students, faculty, and staff in the 1996/97 academic year. In addition, the library develops and supports print and Internet based finding guides, bibliographies and self-paced tutorials for remote learning opportunities.

The library facility is extensively wired (10/100MB Ethernet capability to over 1000 locations including 100 walkup network connections for users with laptops, more than 200 PC/Mac public access, Internet connected computers and two fully networked instruction labs for hands on work and support).

RIT Wallace Library is a highly automated environment, using multiple systems and multiple platforms. It builds, manages and maintains a variety of computer systems and manages multiple hardware and software environments. These range from Unix, to Mac to a large and growing NT environment. At the heart of the library's digital library is a Unix based WWW server, which provides unified access to information offerings. The primary system vendor is Innovative Interfaces Inc. (III), which supports cataloging, acquisitions, circulation, and the public access catalog. The library builds, manages, and maintains an electronic catalog that organizes access to the wide array of information products available. This catalog is based on the MARC (MAchine Readable Cataloging) record structure, an internationally recognized format that describes bibliographic information, provides both a WWW and Z39.50 interface, thereby providing access across multiple clients and interfaces. The library currently supports its own multiple WWW server environment running under a variety of platforms, (UNIX, MAC and NT) and has been a major driver in the campus wide WWW deployment.

The library has made huge strides in delivering digitized content to the learning community. With more than 200 databases, 2,400 full text electronic journals, and online "reserve desk" capability-- allowing faculty to identify specific readings to supplement courses -- faculty and students have a high degree of online access to research material, This wealth of information is available 24 hours a day, 7 days a week, wherever there is a network connection and ISP account.

Recently, the library has developed a multimedia collection in support of specific courses. This foray has expanded the library's collection development, organization, and technical expertise as a direct producer, aggregator, and developer of course material. In

building these services, the library has developed a technical proficiency in digitizing print and image based collections.

Educational Technology Center (ETC)

The Educational Technology Center's mission is "to create and pursue opportunities to help RIT faculty and staff effectively incorporate technology used for teaching, learning and communicating." [2]ETC services supporting the educational environment include media production, classroom equipment support, distance learning and the Media Resource Center, which houses a 50,000 image slide collection, as well as videotapes, films and audio tapes placed on reserve by faculty members for student use.

Image Slide Collection

For years, art reproduction images have been used to supplement classroom teaching and curriculum. RIT faculty requiring a visual component to their lectures (i.e., courses such as The History of Art, American Architecture, Art and Civilization) relied upon a 50,000 image slide collection, locally produced, housed and maintained by the Educational Technology Center.

Internal processes, controls and management compromise image access. A combination of factors limit the effectiveness of the 50,000 slide image collection's use as a campus educational resource:

- ***Image Collection Development*** - Faculty selected images are the core of the huge RIT slide collection. Often the source of the slide image is the Wallace Library's print collection or a slide photograph that an individual faculty member shoots. Overall, there has been a lack in collection development strategy.

- ***Slide Production*** - Photographing, mounting, labeling, cataloging, and filing slides can take over two weeks to accomplish.

- ***Classification and Cataloging***- The classification system used to organize the slide collection originated decades ago from a specialized cataloging system. The maintenance of the system deteriorated over the years. Multiple methods of identifying new slides were introduced into the collection. Locating needed images in the RIT slide image collection is a time consuming, cumbersome process.

- ***Circulation*** - Once slides are selected, they are circulated, in a semi-automated fashion. A slide image is unavailable to others when it is checked out from the collection. The return of circulating slides improved as the integration of slide checkout was moved into the library's circulation tracking system. As of 1998 The RIT art slide collection of more than 50,000 images has been completely entered in to the Wallace Library catalog system which enables better circulation and service. All of the slides have been resheved and are available for viewing and circulation. Returned slides will now be quickly shelved and thus made available for other users.

- ***Viewing*** - Use of slides in the classroom requires delivery of slide projectors to the classroom and the use of slide for individual viewing requires the use of light tables. While the use of light tables only require a particular location and the maintenance of a light table, the delivery of equipment to the classroom requires another level of capital expenditure and staffing to implement. It is anticipated that by Fall 1999 at least 50% of RIT classrooms will have projection capability.

- ***Other issues*** - Additional factors effecting image access have arisen in past years such as copyright compliance and cost containment, forcing restrictive changes in slide production policy.

A solution to image access and distribution for curricular use is increasingly urgent. With RIT's strategic decision to offer an increased number of Distance Learning classes coupled with the growing dependency on visual information in other RIT programs such as Imaging Science, Graphic Arts and the traditional arts it is recognized that the current system cannot scale to the emerging RIT environment.

These factors presented an opportune time to review the slide image collection and its purpose within the educational environment, looking to match it with emerging technical capabilities for image management and distribution. It is an area ripe for consideration of possible changes in process, workflow and the incorporation of technology.

Wallace Library and ETC joined forces and assets. The RIT solution identified was the transition of the existing physical slide collection to a digital image collection. With the use of an innovative digitized system, images could be accessed online and distributed directly to classrooms or desktops. A digital image system would provide management, control, and distribution of images thus improving access and management of a growing resource, allowing for the integration of this type of information into the curriculum and classroom at RIT.

Areas of Examination

Areas of exploration and examination of digital image systems include:

> ***Human Computer Interaction (HCI)***
> *The development and deployment of easy-to-use, effective interface designs. Concerns considered here include response time, general usability of the design, help facilities, use of common concepts, as well as technical, psychological, cognitive and artistic elements as they contribute to a system's effectiveness.*

Technical Standards
Prevailing and developing standards play an important role in the impact on design and industry and provide the basis for accord and acceptance. Technical standards include terminology, definitions, sizes, formats, quality, methods of measurement, and procedures for the production, use, storage and retrieval of information and images.

Technical Requirements
The requirements on the user side (client) necessary to operate the system. These include the user's workstation, browsers, image resolution, bandwidth, and servers.

Educational Issues
The intellectual property rights and copyright issues of digital images and the uses of digital images in the educational process.

Strategic Impact
Concerns include the long and short-term impact on the organization, its users, and the overall success.

Human Computer Interaction (HCI)

The study of Human Computer Interaction (HCI) examines how individuals interact with computers and to what extent computers, systems, and interfaces are, or are not, developed for successful interaction with individuals. HCI has become a significant factor in systems design with numerous corporations and universities researching essential factors that result in successful interface and system design. HCI is an interdisciplinary activity requiring the perspective of varying specialties; often professionals in cognitive psychology, graphic design and the computer systems areas team up to form an HCI implementation team.[3]

Three key issues considered in HCI research include human/computer dialogue, response time, and the use of common concepts (modeling) as contributors to system effectiveness and usability.

Human-computer dialogue is analyzed in terms of its style, structure, and content. There is a variety of options in an interface design. With a command language interface, the user inputs specific language and syntax. While the user has control over the interaction, their knowledge of the language limits the user's effectiveness, potentially generating a large number of error messages and thus frustration. Another type of human-computer dialogue is pull down menus, or "fill in the blank" input boxes. These interface designs offer a limited number of options yet require less knowledge on the part of the user.[4]
The systems discussed in this treatment use the latter dialogue options, as they have been widely adopted and are more readily successful for a new user.

Reasonable ***response time*** requires a high quality interface be designed with this accommodation in mind. In the case of image databases, the issue of response time may force a trade off between image size and quality and user willingness to wait for the image to appear. For many image database systems the issue is addressed with thumbnail images, which are small and load quickly. If the user requires larger images they select that option and only those who want the larger image need wait for it to transmit and display. Response has direct impact on overall usability and user satisfaction, thus impacting systems effectiveness.

Matching ***common concepts*** -- the user's conceptual model or representation of the task at hand -- with that built into the computer by designers is the challenge ***modeling*** attempts to tackle. Of additional concern is the user's mental model of the computer system as well as the system's "mental" model as well as expectations of the user. Modeling considers the existing conceptual framework a user brings and their expectations of functionality and outcomes. The closer the system can match user expectations and apply common concepts, the more intuitive and functional the system will prove to be.

In addition to these important issues, design experts take into account supplementary issues such as technical, psychological, cognitive and artistic elements and how to factor them into system effectiveness and usability.

Technical Standards

Standards perform an imperative function as applied to image database creation where image size, format, quality, storage, and retrieval are all factors that contribute to an effective system. Examples of standards relied upon in the library community and applicable to the design, manufacture and use of image systems include metadata, Z39.50 protocol, and image formats.

Metadata is data about data. Metadata is structured descriptive data about other data that, when employed, leads users to the information wanted and needed. With the ubiquitousness of the Internet and as the sheer amount of information available grows exponentially, metadata has taken on increased importance.

Library produced bibliographic descriptions (i.e. the cataloging of works, such as the MARC record (MAchine Readable Catalog)), are forms of metadata. Librarians have been creating metadata since the earliest days. In some ways metadata can be seen as an outgrowth of cataloging and/or indexing data, yet in the context of the Internet it is much more. Today's digital and networked environment, with its mounting need for development, integration, and management of large-scale systems, raises the importance of this type of work to the forefront.

In addition to MARC, two other metadata systems are relevant to this discourse: Resource Description Framework (RDF) and Dublin Core.

Resource Description Framework (RDF) provides a framework in which independent communities can develop vocabularies specific to their needs and shares these vocabularies with other communities. The following definitions provide a select understanding of RDF and its role as a structure for metadata:

> "RDF—the Resource Description Framework—is a framework for metadata; it provides interoperability between applications that exchange machine-understandable information on the WWW. RDF emphasizes facilities to enable automated processing of web resources. RDF metadata can be used in a variety of application areas; for example: in resource discovery to provide better search engine capabilities; in cataloging for describing the content and content relationships available at a particular web site, page, or digital library...and in many others. RDF with digital signatures will be key to building the "Web of Trust" for electronic commerce, collaboration, and other applications." [5]

> "RDF provides a standard way for using XML to represent metadata in the form of properties and relationships of items on the Web. Such items, known as resources, can be almost anything, provided it has a Web address. This means that you can associate metadata with a Web page, a graphic, an audio file, a movie clip, and so on." [6]

In order to share vocabularies, the RFD terms must be spelled out in detail. The descriptions of these vocabulary sets are called RDF Schemas. A schema defines the meaning, characteristics, and relationships of a set of properties, and may include constraints on potential values and the use of properties from other schemas. The RDF language allows each document containing metadata to clarify which vocabulary is being used by assigning each vocabulary a WWW address. The schema specification language is a declarative representation language influenced by ideas from knowledge representation (e.g. semantic nets, frames, and predicate logic) as well as database schema specification languages and graph data models.

One of the best-known schemas is the Dublin Core (DC), invented by the library community (first meeting held in Dublin, Ohio, USA). The Dublin Core is a metadata set originally designed for author-generated description of WWW resources. It has attracted the wide spread attention of formal resource description communities such as museums, libraries, government agencies, and commercial organizations. Most of the DC elements have commonly understood semantics; roughly the complexity of a library catalog card—it is designed to be used by resource description specialists as well as generalists. The Dublin Core goal is to provide a commonly understood set of descriptors that will assist usability across disciplines and systems. It is intended to encompass internal standards and its developers are active participants in international metadata development groups.[7]

The Dublin Core is intended to be an economical alternative to more elaborate cataloging systems (such as MARC) yet include flexibility and universal descriptors to allow inclusion and mapping to more elaborate metadata systems. For example, although the Dublin Core is simpler than MARC it does map well to the MARC system, thus allowing for interoperability with most libraries cataloging systems.

For this discussion, the importance of metadata to the integration of systems and transference of content is critical. Within this context, the function of metadata is to aid in the identification, description, location, and management of Internet and network

accessible resources. Adherence to an accepted mapping or emerging metadata structure is a requirement of all the systems case studied in this thesis.

Z39.50 protocol, developed by the international library community, is an established world wide standard for communication between computer systems and possesses a stateful protocol that, unlike most web-based systems, maintains an active connection between client and server. Z39.50 protocol specifies data structures and rules that allow a client machine to search databases on a server machine and retrieve records that are identified as a result of the search. This protocol allows users to search across multiple, diverse systems using the query language of the native system. It allows a user in one system to search and retrieve information from another Z39.50 compliant computer system without knowing the search language used by the other system. This eliminates the need for the user to be knowledgeable and fluent in multiple system query languages offering the advantage of reduced training for end users and increased cross system searching. Z39.50 can also facilitate a wide range of library functions that require database searching, including cataloging, interlibrary loan and reference and research assistance.

TIFF and JPEG image format standards are common and are used extensively in image database collections in libraries.

TIFF (Tagged Image File Format) is a bit-mapped image format. Developed by Aldus (now part of Adobe Systems Incorporated), TIFF has been in use since 1986 as a globally recognized image format. It is commonly used in desktop publishing, word processing applications and for image manipulation processes, but because of image size, not appropriate for the delivery of content on the World Wide Web (WWW). TIFF images are generally portable into other graphics and desktop publishing applications and are larger and of higher quality than JPEG images even when compressed. TIFF images are often used for archival purposes in library applications.

JPEG (Joint Photographic Experts Group) is a standardized image compression mechanism. JPEG uses a "lossy" compression method where some of the parts of the original image are "lost" for decompression purposes. However, the elements that are lost are done so by design; they are imperceptible to the human eye. JPEG compresses either full-color or gray-scale images and works best with photographs and artwork intended as viewing images, reducing size with out perceivable quality to the human eye. JPEG is a common format for image retrieval via the WWW.[8]

Technical Requirements

User-side technical configuration requirements are the minimum needs necessary to effectively operate the system. For each of the image database projects, commonly available projection equipment, LAN and Internet connectivity is assumed.

Further, all systems discussed are to operate over dial-in and Ethernet based networking systems with reasonable response time and using standard browsers.

The resolution, and hence the quality, of the image viewed depends on the hardware on which it is viewed or projected. Displaying images on a computer screen is dependent on three factors: (1) the processor speed and memory of the computer, (2) the video card and (3) the maximum resolution of the monitor that determines quality[9].

Basic workstation requirements are at a minimal level; i.e. MAC or PC connected to the RIT campus network or directly to the Internet. An example of the requirements of a typical end user system is the current personal computer configuration requirements for RIT Distance Learning students:[10]

Pentium w/ 90 MHz processor or higher with Windows 95, Windows 98, or Windows NTMacintosh PowerPC with system 7.5.3 or higher
32 Megabytes of RAM
20 Megabytes of available hard drive space
CD-ROM drive
Sound card and speakers
Modem (28.8 K) or better
World Wide WWW/Internet access
Standard browser such as Netscape Navigator (3.0 or higher) or Microsoft's Internet Explorer (3.0 or higher)

Authentication by domain name to identify qualified users will be the minimum level of authentication provided by an image system. RIT provides additional levels of authentication using a proxy-server to further authenticate authorized users connecting from non-RIT domains. The proxy-server uses DCE (Distributed Computing Environment) campus computing accounts to provide the authentication.

Clients systems should only require a current version of a standard Internet browser such as Netscape of Internet Explorer. If other clients are needed it will be transparent to the user.

Server Side Requirements for the digital image systems studied operate under Z39.50 server, NT server, and/or a standard WWW server (i.e. Apache, Enterprise, and Netscape).

Image resolution should be adequate for screen displays and classroom projection. Ideally, the systems will have multiple resolutions appropriate for the specific use. It is desirable to have high resolution TIFF images available for archival and research uses.

Educational Issues

Issues related to the uses of digital images in the educational process and concerns surrounding copyright and intellectual property rights include:

Copyright and use is a complicated issue in the innovative and emerging digital realm. With digital images, the questions become thorny as images must be reproduced and displayed to be educationally useful. Further, an often-requested use of digital images in the educational setting is the alteration or manipulation of the original. This is an expanded use of the content and touches upon artistic authenticity and derived works. For this discussion, the digital image systems discussed vary by source and in the authorized use of the images, but all do permit the educational use of the images including projection and display and use in study collections. These allowances cover the basic instructional needs for utilizing digital images.

Licensing vs. Ownership of information and material represents a shift from the traditional paper and analog content acquisition environment where material is purchased and its use is secured over the life of the medium or organization. In each image systems outlined, the use of digital images is licensed rather than purchased and owned outright. The shift from ownership to access does present challenges for the content providers and users and the implications of this swing will not be fully realized for some time to come. Given this reality, in considering the digital systems studied, we consistently evaluated issues of continuity, long-run image availability, licensing terms and limitations, size and scope of the online collection, source of the image as well as distribution rights.

Digital Images in Teaching as related to the use of images in RIT curriculum represents a beginning transition from analog slide collections to digital image collections. Both content and image qualities have arisen as major issues in the progression of this transformation. In addition, time, training, and availability of facilities and equipment have emerged as conversion barriers. The shift from a physical slide collection to digitized image collections requires sufficient content for course development, adequate projection and personal equipment for delivery and ample opportunity for learning new digital tools and navigating online collections. The question of image quality, while raised has been minimized as a potential impediment. Instead, it is often content and course redevelopment is perceived as major obstacles.

In a pioneer undertaking in the use of digital images in education, entitled the Museum Educational Site Licensing (MESL) Project, several key finding were issued in their 1999 final report:

> It will be a long time before digital image repositories will be able to deliver the critical mass of images needed for instruction and research. Analog slide libraries and digital image repositories will necessarily coexist for many years.
>
> The higher education community is enthusiastic about providing access to digital images and information from cultural heritage repositories. However, many impediments to widespread adoption must be dealt with—ranging from lack of comprehensive content and the absence of necessary tools to facilitate use, to inadequate recognition and support for faculty who adopt new technology in their teaching.
>
> The anticipated shift from analog slide libraries to licensed digital images represent a shift from ownership to access through ongoing subscription. This shift is analogous to the changes that have taken place in university library collections. University

> administrators are concerned about controlling content costs and faculty is concerned about ongoing access to the images they use and need. Those university positions are at odds with those of museum image distribution consortia, who seek a consistent revenue streams and is reluctant to assure ongoing access without ongoing payment. For such image distribution schemes to work, both museums and universities have to see their common goals as outweighing their individual concerns.[11]

Clearly, there are issues in moving to a new teaching method. However, there are advantages to the use of digital images that outweigh the obstacles such as:

- Study collections accessible to both the local and the remote (i.e. distance learning) user in an "any time, anywhere" format, thus eliminating the need to travel to the library to select or view images (i.e. electronic reserves).
- Potentially, a larger array of digital images to incorporate into a curriculum.
- Multiple uses by different disciplines of the same image.
- The option to make use of images in student work.
- Easier management of the digital image thus improved access to the images.

The transition to a digital image environment will be lengthy evolution with multiple issues to resolve. The analysis of the following case studies is based upon the belief that eventual transformation will result in a better quality experience for the student and faculty member, ultimately enriching the teaching and learning environment.

Strategic Impact

Strategic impact refers to the long and short-term benefits delivered to the organization, its users, and their overall success. Examples of benefits include product enhancements, improved delivery, improved quality, cost savings, and impact on the organization's mission--enabling culture change. In evaluating strategic impact, two factors to be considered are the organizations core competencies and its organizational goals:

Core competencies are those areas, skill sets, and resources that are central to the organization and organizational mission. A review of core competencies is a critical factor in evaluating the strategic impact that a new system or service will have on an organization's future. In fact, it is through the identification of these core competencies that strengths and possible directions to pursue will be revealed. In the context of strategic impact, it is the reference points to consider in looking at future directions. For a good strategic fit the proposed system or service must be consistent with existing core competencies, or the organization must be willing and able to develop the appropriate set of competencies and strengths to integrate the system. A core competency review keeps development and investment consistent with existing strengths and directions.

Organizational goals are fundamental to a strategic fit in the evaluation of an organization's goals in light of a new product service or system. Does the new system enhance and advance the organization in regard to established short or long-term goals? How does the system or service fit? The answers to these questions will establish the strategic fit.

Case 1: An HCI Approach to Developing a Local Image System

In May 1997 a team from Xerox, Inc. approached Rochester Institute of Technology Wallace Library and the Educational Technology Center (ETC) to partner as a Human Computer Interaction (HCI) work team, on a to-be-determined timely digital library issue.

This joint work team selected to design and develop a digital image access and distribution system to improve access to visual resources (i.e. slide images) that support the teaching and learning activities of RIT. The HCI team consisted of people from both organizations with a cross section of disciplines. It included anthropologists, computer scientists, librarians, media specialists, cognitive psychologists, catalogers, and videographers.

The team employed integrated multiple approaches to determine user and system requirements. Approaches were of a visual and textual nature including interviews, video taping, audiotaping, co-design work sessions, flowcharting, and multiple planning meetings. For example, multiple sessions with end users (i.e. students) and support staff were conducted, videotaped, transcribed and discussed with the people interviewed to acquire a thorough and accurate understanding of their needs and image use requirements

Essential to discerning the user side was the iterative steps of interviewing, documenting, reviewing, rechecking and re-documenting to reach a recognized understanding. A graphic project plan/timeline as a primary planning and tracking tool, and a structured and detailed plan of work was developed. Simultaneous activity took place such as establishing the copyright guidelines for the database, extensively investigating technical issues ranging from the evaluation of current state of standards to hardware requirements, and the investigation of image quality and resolution issues. The interdependencies of various parts of the project were identified to assure that all teams had the needed information to progress.

Projected to take approximately 18 months to produce a workable 1.0 version of the software (available Fall Quarter 1998), the software completion date was pushed back to December 1999 as the project evolved, with version 1.0 becoming available spring of 1999.

The issues in developing a digital image collection span the technical, environmental and personal. They include questions involved in most large-scale system designs such as use of standards, technology choices, process flow, and general usability. At the heart of this system design is confronting factors in a fashion that facilitates wide spread change and insures satisfactory system life span and timing. What follows is a discussion of select issues involved in each of these areas.

Human Computer Interaction (HCI)

In considering integration of a digital image database into the current RIT learning environment, the work team examined two options: establishing a independent image-only system and integrating the image database into the existing library catalog system (III's Innopac). While each has advantages, the option of integration with the existing catalog system held the most weight.

It was determined the approach of integrating the image database into the existing library system would allow users to quickly search a single, familiar environment for local holdings and images and provided support for existing bibliographic standards; factors critical to an effective and user-friendly design. It was known that the Innopac interface loaded at a reasonable speed and response time was sound. Further, it was deemed important to integrate visual information with textual information as a goal of the overall system design. Presenting users with information of various types in an integrated search provides the richness of retrieval of various formats of information. Using an integrated approach, a user could search for example on "Van Gogh" and retrieve images of his work, full text articles on the artist and his craft, art review citations and possibly in the future, audio and video information.

Essential to the overall interface design was the issue of functionality. Development factors central to the image database design were multiple feedback loops from RIT faculty, students, and support staff, including Library systems staff. Feedback was sought from users of images in their current physical form and in-depth discussions of anticipated needs were conducted. From user feedback an important common concept that would drive functionality was identified -- the "slide table" or "light box" metaphor. The slide table is a long-established and common image-viewing tool allowing one to examine physical slide images over a backlit box. This concept carried through to the design of the system's user interface. Transforming this metaphor into a digital environment assists in the usability of the system offering the end users an easier learning curve by using familiar tools in a digitized setting.

With this as a promising start, additional functionality required in the use of images still needed addressing. The image user population at RIT is diverse ranging from the traditional visual disciplines (art, photography, and design) to new users emerging in the sciences and imaging science. Each user population has its own unique approach to the use of image material and a level of overlap exists. From a teaching perspective, the images needed to be a high enough resolution to reveal and display the learning point being discussed such as subject, form, style, color, detail, etc. In addition, in selecting images for classroom teaching there needed to be a large base collection to select from and the images needed to be documented as well as easily maneuvered to present in the appropriate sequence. There also needed to be a way to quickly add new items to the collection for use in a specific class and to build the base for future classes.

From the student perspective, the images used in class need to be readily available for review and use in student presentations and projects. In addition, an easily searchable, enriched image collection, integrated into other media types offers a richer research environment for student learning.

Technical Standards

In looking at the possibilities of moving the slide system into an electronic environment there was a strong commitment to the investigation and use of standards and integration into existing systems. In the library environment, the automation system that RIT Wallace Library uses is a well-known and widely adopted library automation system procured from Innovative Interfaces Incorporated (III). It includes, among other functions, cataloging, and a web-based public access catalog. The library standard for capturing bibliographic information is the MARC record structure and the III system uses at its base the MARC record. Re-engineering of the slide image collection placed the III and MARC record as the base of the new system. Considerable research was conducted on the state of metadata for visual records and for the use of metadata in an electronic environment. The MARC record structure was adopted as the basic record structure for the cataloging metadata and will also map to the Dublin Core, the emerging approach for recording metadata in the web environment.

Another factor considered was Z39.5, which has a rapidly expanding server-installed user base, allowing the searching of multiple databases using a common user interface. Potentially a RIT user would use just one web interface to search the local environment and remote databases in a single search using a familiar interface with the results returned in a consistent way. This would offer the project a strong advantage, as more Z39.50 compliant image content databases become available for loading and access over the Internet. The use of Z39.50 protocol was supported by the Wallace Library installation and operation of a Z39.50 server on the III automation system of the library, to run in conjunction with the library web server.

When examining the issue if image resolution elements considered included:

-*Image size:* high resolution means a greater storage space requirement.

-*Transmission speed:* the higher the resolution, the slower the image is transferred. This implies high bandwidth to pass high-resolution images.

-*Local manipulation:* the higher the resolution the more power required at the user workstation end.

-*Projection capability:* current projection technology that is of reasonable cost limits the resolution. However, this capability continues to increase at a rapid pace and a declining cost.

-*Screen size:* convenient viewing of single or multiple images is dependent on screen size. The current user environment is a 15-inch screen that is best suited for displays a lower resolution image.

-*Browser display:* current popular browsers display at 640 x 480 pixels, which may require resizing or additional software to fit the image to the browser displays size.

-*Resolutions available:* what image resolutions should be available to the user? Thumbnail only? Thumbnail and a larger medium/high resolution image?

-*Archival resolution:* should an archival image be maintained? At what resolution? On what medium should it be stored?

Image resolution standards chosen for the RIT image system included a thumbnail (160 x 120 pixels), a mid-range resolution (640 x 480 pixels), and a high resolution (800 x 600 pixels). In addition, an archival uncompressed TIFF image would be maintained on CD-ROM. Central to the issue is the trade off between the highest resolution that's practical for a specific use.

Technical Requirements

To insure success in the use of digital images in instruction and learning, campus access and infrastructure support is essential. High-end bandwidth is critical for the distribution of images more so than for distributing text.

The goal of the local image system project: images would be downloaded easily over the Internet using regular modem speeds, minimal bandwidth requirements and accessible from both Mac and PC platforms using a standard browser. The system developed fits within the distance learning workstation requirement described prior.

In a digital environment, upgrade commitment is an ongoing one where increased capacity at the workstation end certainly follows with increase in functionality. In the advanced manipulation of images, these capabilities continue to require higher end power and functionality.

Educational Issues

In the digital arena, copyright is a hotly contested item. Appropriate use of electronic text, images, and multimedia is debated throughout our legal and judicial system with the interests of publishers, authors, and users juxtaposed. In an educational setting, the principle of "fair use" governs library and educator's rights to use and reproduce material for a non-commercial, educational purpose without infringing on publisher and author's rights.

In a print environment, fair use is focused on the photocopying and distribution of material. Issues of coursepacks (topically related collections of articles and other copyrighted materials) and faculty reserve (placing copies of articles on library reserve for student perusal to supplement class teachings) are traditionally common point where copyright has been debated between educators, librarians, publisher and lawyers. In a digital environment, the ease of potential reproduction and distribution worldwide has opened a huge debate and a rethinking of international and domestic copyright laws. The publishers of information are lobbying for extremely strict interpretation of copyright that threatens the principle of fair use in educational environments.

The current copyright situation is in a state of flux. There are multiple interpretations of appropriate use of electronic information with little agreement. Within the academic environment, individual institutions are adopting and establishing a variety of interpretations of "fair use". The approach that the local image project team made in determining how to provide educational access to the use of the images is a complex issue currently under discussion. The existing position is:

-RIT will secure copyright permission for images whenever possible. This includes purchasing or licensing image collections when available. We will pursue purchasing databases that provide, whenever possible, access to thumbnail, midrange and high resolution images. When images that support RIT curriculum are not available for purchase, RIT will produce a digital image (thumbnail only), from print sources.

Following the RIT Wallace Library electronic reserve model currently in place, access will be restricted to RIT users through IP authentication and images may further be controlled at the class member level through the use of passwords. Only registered students of the class will have access to select images.

- Clear copyright statements of "fair use" will accompany all image displays.

This issue remains hotly debated and is currently under advisement with RIT's attorneys to ensure no legal recourse against the institute. The findings of the lawyers and the RIT decision may alter the approach that our locally developed image system project will take for images that are not copyright cleared.

Strategic Impact

Strategic impact refers to the long and short-term benefits delivered to the organization, its users, and their overall success. Strategically, a locally maintained and mounted collection (vs. a vendor supplied and supported configuration) may be preferred as it allows for local control of the system, content, function and service. These advantages must be contrasted with the scope of task surrounding such an undertaking --

multi-level support requirements of a local functional and operative database structure such as leadership, staffing, and hardware/software expenditures.

Further, issues of copyright and image use, up-to-date standards and technical expertise and a dedicated finger on the pulse of emerging directions must be found in-house, as opposed to what can be depended upon when purchasing a similar system from a for-profit outside source whose service focuses solely on such concerns. Each issue represents a significant undertaking that can prove challenging for an individual institution to traverse alone and may not be a valid option for some universities.

In examining strategic impact and its ability to enable a culture change it must be recognized the concurrent training of both faculty and students in the use of the equipment in the classroom and labs and in the use of the software and digital collections will be an ongoing challenge critical to the successful implementation of a shift to a digital image collection.

A locally produced image database system are fundamental to a strategic fit is the evaluation of an organization's goals in light of a new product service or system. Does the new system enhance and advance the organization in regard to established short or long-term goals? How does the system or service fit? The answers to these questions will establish the strategic fit.

A review of the core competencies of Wallace Library and the Educational Technology Center (strong technical experience, history of working with faculty and images collections, strong on line presence, experience with building and maintaining databases and web based resources) shows the existence of established skill sets and resources in support of a centralized undertaking. A local image delivery system is consistent with existing core competencies. Related to the larger picture of the campus as a whole. The new system enhances and advances the organization in regard to established long-term goals.

Case 2: Participation in Beta Testing an Image Delivery System

A second approach to obtaining and disseminating digital images to the RIT community is through Wallace Library and ETC's joint participation in the AMICO (Art Museum Image Consortium) Testbed Project.

AMICO is a not-for-profit consortium of 23 of the largest art museums in North America, joined together to improve educational multimedia access to the objects in their collection. The comprehensive membership base of the consortium offers a rich content of images to be digitized and a commitment to digital image exploration and documentation.[12]

The AMICO Library is the compilation of digital multimedia documentation of works of art contributed by AMICO Members. All full members of AMICO contribute documentation of at least 500 works from their collections annually. AMICO then adds value to the compilation in ways that include standardization and indexing.[13]

The University Testbed Project itself was established by AMICO and operated during the 1998-99 academic year, testing access to, and curricular utility of, 20,000 art and photography digital images.

RIT was chosen to participate by AMICO, joining a select group of universities such as Carnegie Mellon University, Columbia University, and Harvard University, to explore issues related to the licensing and delivery of multimedia museum documentation to higher education. RIT Wallace Library and ETC extensively investigated and reported on studies of uses, user needs, authentication, and library development priorities, as well as studies of color management and licensing issues.[14]

The AMICO Testbed collection consisted of two-dimensional art; available over the Internet in four resolutions for browsing, searching, classroom projection and other educational licensed uses. For the testbed year the library consisted of approximately:[15]

- 9000 works from Europe, including ancient Greece and Rome;
- 8000 works from North America, including Pre-Columbian (Meso-American) art;
- 2000 works from Asia, including ancient Asia Minor;
- 400 works from Africa, including ancient Egypt;
- 65 works from South America; and
- 35 works from Oceania.

While the AMICO collection is primarily two-dimensional Western art, it does include multiple artistic genres, including painting, sculpture, photography, drawings, textiles, architecture, furniture and other artistic forms. The collection will grow in all these areas over time. The collection is projected to grow by approximately 10,000-

20,000 images per year through academic year 2006/2007. As of July 1999, the start of year 2, the collection is at 50,000 images. Thus, the usefulness of the collection as a scholarly research tool will grow as well as its relevance to multiple disciplines will expand.[16]

The project ran for a full academic year. The library conducted multiple information and training sessions to faculty students and administrators on the availability and potential use of the collection. Several faculty from multiple disciplines integrated the collection into curriculum and student assignments. The cumulative participant Testbed Project results and feedback led to the licensed database now available to the educational community called The AMICO Library. RIT Wallace Library has licensed use of the AMICO image database for educational use.

Human Computer Interaction (HCI)

From a human computer interaction perspective, the AMICO Library Testbed web site was well constructed, easy to navigate, visually appealing and an effective interface design. Overall, the interface loaded at a reasonable speed even at dial up modem speeds of 28.8k.

The entry screen offers a "slide show" of several images from the collection and provides guidance for display settings and window size settings. This offers initial users help at the beginning of the session, prior to displaying search results, thus minimizing user frustration.

Functionally, image access is provided via a simple search option (keyword, creator, and title) or the advanced search capability. The Advanced searching function provides for additional searching on phrases, dates, materials, etc. and adds a Boolean search (and, or, not) capability. It also provides a useful feature that presents straightforward guidance on what is searchable as each index is selected.

The AMICO interface design uses common concepts to explain features. Common concept examples: a simple "eraser" icon used for correcting entries and a "notebook" concept to select and store records from different searches for later use. In this way, the interface allows for personalization of the searches and retention of research within the tool. The user's notebook can be printed, downloaded or e-mailed (through an e-mail enabled browser) at any time. The notebook concept transfers from a commonly understood physical notion into a digital function providing for ease of use.

A complimentary feature of the interface is the suggestion of how to improve result sets when no hits are returned. It offers the simple, but often overlooked suggestions of simplifying the search by using a single index, checking spelling of the search query or consulting a librarian for help. In addition, the interface allows for comments to the web team, a help file on system use, and a link to the AMICO web site.

A confusing part of the testbed entry screen surrounded the search instructions of the initial screen. While there are directions to type an entry to begin a search, there is not a place to enter the data and the user must select the "search" button and then enter the search criteria and begin the search.

Another difficulty is the awkwardness of screen size and the use of multiple windows while traversing the database. With multiple windows the users desktop tends to clutter also causing frustration. The limits of screen size mean that while the initial screen offers tips to overcome display issues, this information is available at the bottom of the screen requiring the user to scroll downward to see it. If the user doesn't see these recommendations, they are likely to experience frustrations displaying search-result images, as the images will not be readily visible in the initial screen.

Technical Standards

The AMICO Library entries consist of the actual digital image, descriptive cataloging of the image and metadata documenting the image. Based on the owning museum's documentation, entries may also include image details and alternate views, collection data, curatorial records, original scholarly research, and other educational material related to those works, much of it not published in other forms.[17]

The AMICO Project follows The Consortium for the Computer Interchange of Museum Information (CIMI) protocol. CIMI is a not-for-profit initiative to develop community standards that support the preservation of museum information in digital form and enhance the potential for information exchange.[18]

The specifications for contributed records to the AMICO Project follow accepted standards and practices that will allow for long term use and integration with other systems. From the AMICO FAQ addressing the question of integration with other systems:

> The AMICO Library Technical Specification conforms to many information systems standards which are specifically designed to assist in such integration. The AMICO License explicitly allows for the integration of AMICO cataloging data in OPACs.[19]

What follows are selected excerpts from the record specifications for contributions to the AMICO Collection. This is offered as evidence of the strict adherence to standards and the depth of that specification:[20]

Related Image and Multimedia Files Specification Version 1.0

1. "MAIN IMAGE" CONTRIBUTED TO AMICO

Each work of art contributed to the AMICO Library must be documented by at least one image, showing a full view of the work.

1.1 Resolution

Images contributed to AMICO should generally have a minimum resolution of 1024 x 768 pixels. Members are encouraged to contribute larger files, to allow for user manipulation.

Existing images at resolutions below 1024 x 768 may be accepted with the understanding that they may have to be replaced in subsequent years. Those museums that intend to submit at a lower resolution are requested to post notification to the AMICO Technical Operations Committee.

1.2 Bit Depth

All images will be 24-bit color.

1.3 File Format/Compression

Images should be submitted to the AMICO Library as uncompressed files in the TIFF format. This will enable future compression by a distributor without loss of quality. Certain research uses also require uncompressed images.

Distributors will be asked to declare their image sampling/compression processes, for AMICO review and approval. AMICO members will also be given an opportunity to review the results of distributor's compression routines.

1.4 File Names

All associated media files, text, image, multimedia, etc., will follow the same naming and linking conventions.

File names will be entered in the appropriate linking field in the AMICO main catalog record: Related-Image-Identifier/Link RIL, Related-Document-Identifier/Link RDL or Related-Multimedia-Identifier/Link RML

As there are many differing schemes in use in AMICO member institutions, file names are not assumed to have any meaning. The characteristics of images are recorded in their accompanying metadata records.

1.5 References in Catalog Records

Each image file contributed must be referenced, exactly, in the Related Image Link (RIL) field in the AMICO Catalog Record. The exact file Name (matching upper and lower case) must be entered in the catalog record to make a link between records and associated files.

Validation routines will test to ensure that all files cited are present and that all files contributed are referenced in a record.

2. METADATA for RELATED IMAGE AND MEDIA FILES

Each image or other media file will be accompanied by a separate structured text metadata record, containing the minimum fields, as specified. Sample metadata records are posted on the AMICO Web site, along with sample image and media files.

3. RELATED MULTIMEDIA FILES

Associated media files will be contributed to the AMICO Library in their native format. i.e. in QuickTime, WAV, RealAudio, etc. and named with the registered MIME extension.

Files must be accompanied by a metadata record and referenced by an entry in the Related-Multimedia group field of an AMICO Catalog Record.

Validation routines will test to ensure that all files cited are present and that all files contributed are referenced in a record.

4. RELATED DOCUMENTS

Related textual documents can be contributed in any common format: Text documents can be in ASCII, or Rich Text Format (RTF), Marked up texts can be in Hypertext Markup Language (HTML) or Standard Generalized , Markup Language (SGML)

Each related document file must be accompanied by a metadata record and is referenced by an entry in the Related-Documents group field of an AMICO Catalog record.

Validation routines will test to ensure that all files cited are present and that all field contributed are referenced in a record.

These stringent standards clearly demonstrate AMICO's serious commitment to consistent content. This presents a very strong and clear advantage to the AMICO Collection as long term use and integration is considered in the acquisition and use of digital images in the educational setting.

There are three image sizes available in the AMICO Collection. They are thumbnail, screen size and presentation size. Thumbnail images appear on brief displays at approximately 90 X 183 pixels. By default, associated text appears as well. There is an option to show image only or text only, which impacts retrieval speeds. There is also the option to see the image in the larger sizes. This is controlled under the Option area of the display or by double clicking the image. Mid size images (Inspection display) are at 640 x 480. Presentation size images are at 1024 by 768 pixels. These image sizes offer options on the display and use of the images and offer the range of thumbnail for fastest retrieval through presentation for highest resolution. These images are JPEGs.

With respect to image quality:

The apparent quality of any image depends on many factors, but in general, the AMICO images are being delivered at more than twice the resolution of most images on the web sites of museums today. The general specification is 1024 x 768 pixels in 24-bit color, which is the maximum screen resolution of most 17" monitors. At this resolution, over 1 million pixels (picture elements) are captured in full color. The perceived quality of this image varies with the size of the original work of art, though. For small objects, it could be a magnification over the unassisted eye; for large objects it could be quite poor.

Some AMICO images are available in resolutions up to twenty times the minimum, allowing for considerable "zooming". However, there are some images in the Library that are not quite this large, either because existing images were captured at a lower resolution, or because the over-magnification of some objects at this resolution, such as ancient coins or miniatures, is distorting.[21]

AMICO also offers the option of even higher resolution TIFF images if ordered through a separate request process and the image TIFF image is sent to the library database administrator. This option is not used often (once in the course of the year) but is an additional option for detailed study of very high-resolution images.

Projection of the images from the AMICO Collection is possible on all projection devices. The choice of image size allows for a full range of projection options that can suit the specs of the projection unit and the use requirement from screen display to classroom display. The quality of this projection will vary on resolution, type, and regular maintenance of the projection units. This will be a major factor in actual use and acceptance of any digital image based system.

RIT's experience in the quality of these images is very good. Certainly, it has been seen to be good enough for study collections, reserve materials and for some classroom projection. A significant variable that impacts this aspect of the usefulness of the Collection is the projection available in a classroom setting and the accuracy of that system's calibration. This will continue to be an issue in any image projection system. Quality control on the actual image is good which will provide a quality base image.

Technical Requirements

The AMICO Collection is accessible through standard web browsers. While it does run its own client, it is accessible using both Internet Explorer and the Netscape browsers. This approach allows the AMICO Collection to be accessible from most workstations and continues the commitment to common standards.

Images from the AMICO Collection are downloaded easily over the Internet using regular modem speeds. Since the basic requirement for distance learning students is a 28.8KB modem. A distance learning student and faculty member in developing course work and curriculum can easily use these images. The bandwidth speeds of RIT's 10/100MB-switched Ethernet network allows for even faster delivery to the classroom or dormitory. This makes the AMICO Collection's bandwidth requirements well within the reach of all RIT students.

Images from the AMICO Collection are accessible from both Mac and PC platforms. Images can be viewed from all standard size screens. Any workstation that can run an Internet browser and has access to the Internet can access the AMICO Collection. This places the workstation requirement well below current level machines. Image quality will vary with monitor quality; access speeds will vary with processor and workstation specs as well as Internet speeds. However, there is not a requirement for high-end workstations or specialized equipment to access this collection. This opens access to a wide audience of currently installed equipment.

Suggestions for best results in viewing the AMICO Collection are:

- Use a display system set to "true color" (24-bit), or higher
- Use a display system set to 800x600 resolution, or higher
- Enlarge your browser's window as much as possible before beginning to search.[22]

Educational Issues

The AMICO Collection offers educational licensing use of the images available. This license encourages the use of the images for educational purposes. Use is generous for educational purposes allowing for use in electronic reserves, integration in On Line Public Access Catalogs (OPACS), teaching, research, distance learning, student projects and portfolio. In fact, "the AMICO Licenses explicitly state that they do not limit "Fair Use" as defined in the U.S.Copyright Act. The Licenses also permit many uses that go beyond Fair use."[23]

The educational license defines users as students, staff, researchers, and visitors to the university. Excluded are users who pay for access to information services or to potential donors who are solicited for funds by access to universities information services.

Images are intended for educational use. Use of images in publicly accessible web sites or in other scholarly publications is not permitted. Since AMICO does not have authority to re-license the works contributed by its members it cannot be granted by AMICO. They do hope to implement a process to allow for this use.

At RIT, we have posted a set of use conditions for the AMICO Collection on the web site of the library. Users must agree to these terms each time in order to enter an AMICO session. Conditions are identified below:[24]

EDUCATIONAL USE AGREEMENT

- You MAY NOT use the AMICO Library for any purpose other than education, research or scholarship.
- You MAY NOT use any AMICO work for any commercially or business related purpose whatsoever.
- You MAY NOT reproduce, distribute, re-distribute, or publish any adapted AMICO work outside of RIT.
- You MAY NOT use any AMICO work for University fund-raising, marketing promotion, or public relations.
- You MAY access and use the AMICO Library for classroom instruction and related activities including handouts, presentations, research and student assignments.

- You MAY use the AMICO Library in a public display or performance in an RIT gallery or similar facility, or as part of a professional presentation at a conference, seminar, workshop or other professional activity.

- You MAY use the AMICO Library for student or faculty portfolios, term papers, theses and dissertations.

- You MAY adapt, alter, add to, delete from, manipulate or modify an AMICO work if you're doing it exclusively for educational, research or scholarship purposes. You MUST clearly identify all changes made to an AMICO work and include an appropriate citation or direct link to the un-adapted AMICO work.

Strategic Impact

At this point the content of AMICO Collection is not adequate to teach an entire course. It is hoped that over time it will be. The following is AMICO's public position on this issue.

> It is unlikely that the AMICO Library will contain adequate content for teaching very many courses entirely from the Library for many years. In some areas there may be adequate depth and breadth in the Library to base a course solely on AMICO content from the first. Over time, it is of course hoped that the AMICO Library will constitute the largest and most important digital resource for art scholarship. But even then it will not replace other sources; scholars will always want to use primary and secondary sources, publications, books, and articles for their teaching and research. [25]

Despite the current content limitations described, the AMICO collection offers the potential to offer several classes use of digital images and to support sections of the existing curriculum. AMICO's commitment to increasing content and requiring rigorous image quality standards demonstrates a clear strategic fit with the direction RIT is moving in. Further, the existing AMICO content allows for the immediate exploration of digital image use which positions RIT to move forward aggressively as more content becomes available overall.

Case 3: Commercial System: The AP Photo Archives

A third image system provided by RIT Wallace Library is the Internet based commercial system AP Photo Archives, providing the educational community access to photos of breaking news and important events almost as quickly as the news media can access them

The AP Photo Archive is a digital image library containing over 700,000 online images culled from the AP's 50-million-image print and negative library dating from the 1800s—with thousands of new and historical additions each week.

Most of the collection is photographs taken since late 1995. Over 800 photographs are added each day and trained indexers select the best 200 or so photos to save permanently while the remainder is eliminated from the Archive after 12 months. Weekly, a selection of historical images is scanned into the Archive. This consists of significant news events of the 20th century such as civil rights, space exploration, U.S. presidents, sporting events, and other major news happenings. [26]

A second database, available through this web site, features the regional European and Asian daily picture reports, along with a selection of their historical photos. This features regional photos from Europe and Asia, some with foreign-language captions. This collection grows by approx. 300 images a day. Similarly, indexers select and save current images to be maintained beyond the one-year minimum retention rate. Both databases are available for searching through the library's subscription.

Human Computer Interaction

The AP Photo Archive image system offers a user-friendly interface geared for both the novice and the advanced user and is well received by users and librarians at RIT. Searching the database uses natural language human-computer dialogue so there is no database-specific syntax to master. A search is executed by inputting search criteria in the WHAT field and further limiting of a search is done by simply filling in the WHEN and/or the WHERE fields.

Searches are executed quickly, taking just an average of 30 seconds response time. Use of images via educational licensing allows for image downloading strictly by screen capture ("right-click") any saving the image to desktop, drive or disk. PC users have the ability to directly e-mail images also.

To further aid in searching, the site includes a section called "Top Five Search Tips" which contains tips with examples and then expands upon this with further details.

This allows the user to see enough to get started and to go further if needed. The style of this assistance is concise, clear, and multi-level.

The interface offers helpful, easy to use features such as clearly displaying the number of images returned, options on numbers of images to view at a time, sorting option, and display option on relevancy (the default is newest display first).

The default database is the main Archive Collection, with the option to search the European/Asian collection coming from a pull down menu. Unfortunately, only one database is searchable at a time, unlike a Z35.50 enabled system.

The Archive applies the common concept of a "lightbox" feature to view groups of images aiding in the intuitive and functional use of the system. Images can be displayed four at a time with full captions, twelve at a time, without their captions showing on screen but rather accessed via a hotlink, or directory style, listing 36 partial captions and clicking on the caption to display the photo. Using this feature, normally up to five separate lightboxes or collections of images are saved, each containing up to 25 images. Within RIT's implementation of the system, only one lightbox is provided for and since this is a shared system it may need to be deleted by the next database user to allow down loads.

This raises the issue of the differences in the standard commercial implementation of this image database and the educational implementation. The prime markets for this database is newspaper and broadcast companies. The help files available online and the screen text are written primarily for the commercial user of this product and may be a bit confusing for the educational user. Onscreen instructions often speak to the commercial user: how to register for use, obtaining passwords, downloading instructions inferring all users are being billed per picture captured and licensing restrictions. None of this pertains to the RIT user.

To address this type of use, RIT has developed a set of help guides and its own trouble reporting system for its users. In addition, library reference help is available (in person, by telephone and by e-mail) as is the AP's toll-free Support Desk.

Technical Standards

The AP Photo Archive database images are all in JPEG format. Contemporary photos are scanned at 200 dpi, and the average file size is 500KB to 600KB compressed. Historical photos are scanned at 300 dpi, and can be as large as 1.5MB compressed. The photos and captions are easily reproducible on an ordinary black & white or color printer.[27]

Features of the interface are handled through the standard web browser, thus no other clients or software is required. Images are able to be e-mailed through a web-enabled browser.

In the RIT implementation of this image system, username and password authentication is bypassed in favor of IP authentication allowing all authorized RIT users to connect directly, or if coming from an outside ISP, connect via our proxy-server.

The characteristics of the collection news service focused and descriptive image information is in the form of plain text. Thus, this collection does not follow standard metadata standards as defined by library or other standards groups making the interoperability between systems difficult if not impossible.

Technical Requirements

The AP Photo Archive can be successfully accessed on the Internet with either a Mac or a PC and Netscape Communicator 4.04 (or greater) browser software. Microsoft's Internet Explorer and other versions of Netscape may offer partial database access but do not properly handle Java script, the programming used in many of the Archive functions such as performing a search or opening the lightbox.[28]

The use of the existing browser functionality adds to the ease of use of this interface. The user does not need to use the features of another client running under the web browser. To view the image full-screen, click once on the Photo. This is nice feature, using a common convention in viewing images

Photos and captions can be e-mailed with e-mail enabled browsers and can be reproduced on standard black and white or color printers.

Educational Issues

The educational issues revolving around intellectual property rights, copyright issues, and the uses of digital images in the educational with this database are consistent with the others discussed.

RIT users must access the database through an introductory page housed on the library's server that transparently authenticates them by IP address, protecting the database from non-paying and non-educational users. In addition, the RIT user accesses the database only after reading the terms of the library's license and clicking on a link that states: "I agree to honor the copyright terms governing the library's license of this database".

Acceptable uses of database images are spelled out to the RIT user as follows:[29]

- You may NOT transmit/download/print the images to/for any non-RIT person.
- AP Photos may NOT be used for any commercially related or business related purpose whatsoever.
- AP Photos are NOT allowed in newspapers, magazines, brochures, catalogs, commercial announcements, calendars, posters, yearbooks, playbills, newsletters, T-shirts, or any similar materials.
- Images are NOT to be manipulated nor can derivative works be created. Exception: reducing or enlarging the size of the complete image is an allowed manipulation.
- You ARE permitted the use of digital copies of images for curriculum-related PowerPoint presentations, slideshows, overhead projection, and/or RIT closed-circuit broadcasts.
- You ARE permitted to use printed copies for book reports, term papers, theses, and class handouts and for research.
- You ARE allowed to use photos on "intranet" web sites for a limit of one academic quarter. "Intranet" is defined as a secure web site available only to those who are members (faculty/staff/students) of RIT and which is closed off from the Internet and/or Wide World Web (WWW) or is accessible to the general public. An example of this is Wallace Library's Online Reserve Service.
- Use of this database is restricted to RIT students, faculty, and staff only. All other use prohibited.

Use of these images are a bit more restrictive than other image licenses that we have discussed but does offer enough flexibility to be of use in an educational setting.

As with the other image databases, the AP Photo Archived is licensed on an annual basis. Thus the images are neither purchased nor secured for any period greater than the extent of the current contract. But, our educational access to this vast wealth of images is at a mere fraction of the cost a commercial user pays and it provides access to images that would be copyright prohibited for RIT use in any other form. The amazing scope of the database, the internationally recognized source of the images, the manageable licensing terms and the low expense of the license were all factors leading to the addition of this database to the library's collection.

To incorporate digital images in teaching requires the constant of time for the revision of curriculum, learning new systems, and tools, and availability of appropriate hardware to use and project the digital image. The content of AP Photo Archives database opens the option for the use of images in disciplines not normally inclined to use visual images extensively. In addition, downloaded images require the use of additional software, (i.e. PowerPoint) to display them within the context of the teachings of a particular class.

Strategic Impact

The AP Photo collection offers access to a large compilation of contemporary images and a growing number of historically significant images. These images can be used in distance learning curriculum, as well as locally delivered classes. The collection offers more content than had been previously available and opens the possibility of the use of images in curriculum beyond the traditional visual disciplines. This allows a larger base for multimedia development in traditionally non-image-based areas.

Case 4: Commercial System: Gardner's Art Through the Ages

The fourth image delivery approach considered in this review is the license of 880 images from the 10th edition of Gardner's Art Through the Ages edited by Richard G. Tansey and Fred S. Kleiner, (New York: Harcourt Brace College Publishers, 1996).

The digital images are purchased through Saskia Ltd.Cultural Documentation, a major slide and image vendor. This resource was purchased specifically for the student and faculty of the course, Art and Civilization, with added benefit to others interested in the study of art history. This collection was selected since the images of the Gardner book forms the base of the images used in the Art and Civilization classes at RIT. These images were added to the library's electronic Innovative Interfaces Inc. (III) Innopac catalog, which the library builds, manages, and maintains.

Human Computer Interaction (HCI)

Access to the Gardner images is through the online web based catalog of the library. Images are integrated into the system for general retrieval through the access points of word, title, and author (including artist). Subject searching is not available as the cataloging of these images do not contain subject entries. Searching is via the general catalog of the library thus minimizing specialized user training. Images can be saved for further use in other tools, (i.e. PowerPoint). A simple way to view all 880 images in the collection is provided from the entry page via a mouse click on a predefined area. These images are also searchable via the Z39.50 client. A help facility is provided via locally developed help files.

Technical Standards

The metadata cataloging for the Gardner images conforms to subsets of the Dublin Core and VRA standard and is mapped to the MARC record. Descriptions for the images are entered in MARC format and contain basic elements of VRA and Dublin Core structure. Images are linked to the cataloging information through the 856 MARC field tag defined for web links.

Images are available through a Z39.50 client as well as through standard web browsers. The images reside on a library web server and are high quality JPEG compressed files in full 24-bit color. Images are stored in three separate resolutions:

High-resolution: 1024x1536 pixels, compressed to 1MB
Screen-size: 512x768 pixels, compressed to 200KB
Thumbnail-size: 128x192 pixels, compressed to 20KB

As noted prior, high-resolution images are ideally suited for detailed study or in-class projection; screen-size images are for general use where speed of transmission is important, or viewing hardware is not as advanced; and thumbnail-size images are for easy integration into image or slide management databases.[30]

Technical Requirements

The Gardner images are successfully accessed via the Internet with either a Mac or a PC with access to the Internet or the campus LAN and Netscape Navigator 3.x or higher, Microsoft Internet Explorer 4.x, or a compatible browser.

The most important hardware consideration for viewing images is the size, resolution, and quality of the display screen or projector. 24-bit color displays are highly recommended. 8-bit color displays are not well suited for critical study.

Users are authenticated via domain name IP filtering for on campus and users of the RIT dial IP facility, For those RIT users who have an alternative ISP; the locally developed proxy server authenticates users via DCE accounts.

Educational Issues

The Gardner material is the most restrictive in terms of copyright and educational use of all the images systems discussed so far. The terms of use agreement read:

> Use is restricted to RIT students, faculty, and staff for educational and research purposes only. This image may only be viewed from this Web site and may NOT be downloaded, copied, printed, photographed, placed on transparency or reproduced in any way.[31]

This collection allows for the display of thumbnail images that can then be retrieved from the analog slide collection for use in the classroom. This solves some of the image management issues of the current environment discussed in an earlier section. It also allows for the creation of study guides for anytime any place viewing and provides faculty the ability to view images from any network location. While this is not perfect, it does offer some improvements to the analog only environment.

Strategic Impact

The Gardner collection is targeted specifically towards students taking the RIT class *Art and Civilization* and the faculty that teach this class, making great use of the make use of the textbook *Gardner's Art Through the Ages*. The varied Gardner images provide a base of content to support these art history classes. While this is not all the content used for the class, it does provide a foundation. This collection, supplemented with other collections and individual images, provides the possibility for delivery of the class *Art and Civilization* in a distance learning format and gives shape to rethinking the classroom delivery methods of this course. Students are now able to view the images presented in class in an "any time, any place" format, and faculty may place notes of their lectures, along with corresponding images, on electronic reserve to supplement classroom activity.

Summary

Each of the systems discussed offers its own advantages and disadvantages. The following section will provide a brief outline of respective pluses and minuses.

Case 1: Locally Developed System

Advantages:

- Tailored to the environment, provides integration with the local catalog and circulation system and offers the potential to streamline image management system.
- Uses existing standards, provides the potential to search across multiple databases in a single search.
- Allows for local input of images for faculty owned images.
- Allows for full system integration.

Disadvantages:

- Collection building a labor intensive, slow process, thus use of system (due to content deficiencies) will progress slowly.
- Copyright and legitimate uses of images vary across collection depending on the source of the image. This is difficult for the user to integrate.
- Local development and maintenance costs are high in terms of staff, software, and hardware.
- Client software deployment across platforms of user base will be labor intensive and will require a higher software base among users that is currently in place.
- Image quality varies based on local scanning

Case 2: AMICO Testbed Project

Advantages:

- Large and growing image collection of academically based and useful images
- Favorable educational use terms
- Image quality is consistently high
- Tied into national effort and national/international image collections
- Strong use of standards
- Web accessibility
- Continual system development

Disadvantages:

- No local control over system development
- No local collection control
- No facility to add local images
- Separate system
-

Case 3: AP Photo Archive

Advantages:

- Large image collection of general interest
- Good user interface
- Web accessibility, common browser use
- Low cost
- Image quality good
- Favorable educational use terms

Disadvantages:

- Collection is not academically based, more current awareness, historical images
- No local control over system development
- No local collection control
- No facility to add local images
- Not based on national image metadata standards
- Separate system

Case 4: The Gardner Collection

Advantages:

- High quality images
- High content relevancy to academic users
- Integrates into local collection

Disadvantages:

- Very strict educational license terms
- Images only, thus requires other system to provide delivery of images
- Need to develop and integrate metadata for description which is labor intensive process
- Limited content

Summary Chart

The following chart offers additional summary and comparative information on the four systems discussed.

	Local Development HCI Approach	AMICO Testbed Project	AP Photo Archive	Gardner Collection
Factors				
HCI:				
Speed	4	4	4	4
Ease of Use	3	4	4	4
Help	3	4	4	3
Screen Layout	3	4	4	4
Tech Standards				
Metadata & Access standards	3	5	2	4
Image size	4	4	4	4
Access	3	4	4	4
TIFF/JPEG	Yes	Yes	JPEG	Yes
Tech Requirements				
Browser/Client	3	5	5	5
Server	Z39.50+web	Web	Web	Web
Authentication	4	4	4	4
Image Resolution	3	3	3	3
Educational Impact				
Content	1	3+	3+	2
License or Ownership	Varies	License, multiyear	License	License
Archival copy	5	4	3	3
Copyright	Varies	4	3	2

Scale:
5= outstanding, 4=very good, 3= ok, 2= trouble spot, 1=poor

The discussion presented above attempts to identify some critical issues in the use of image collections in an educational environment and one institution's varied approaches to integrating images into its database offerings to its user base. Each system

discussed provides a building block to the movement of digital image delivery to the academic audience and process. Ultimately the goal to transform the analog image delivery systems to digital delivery systems is an attainable one. The review presented offers a snapshot of the current issues involved in the state of this transition.

The Future

We will continue to experiment with the use of images and the integration of them into the teaching curriculum. For the short term, users will need to consult multiple collections to support their image needs. Long term, we anticipate the emergence of a single tools or interface that will allow the integration of images from multiple collections to be use in a unified way. Work on interface standards, metadata and ongoing image capture needs to continue at the local, national and international levels to make this a reality.

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